Physical Fitness Performance of Young Adults with and without Cognitive Impairments

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Abstract

The purpose of this investigation was to analyze the physical fitness performance of young adults with and without cognitive impairments. Participants were 75 young adults, including 41 without disabilities (23 females, 18 males; *M* of age = 21.88) and 34 with mild cognitive impairments (14 females, 20 males; *M* of age = 21.79). They received measures on seven test-items selected based on *The Brockport Physical Fitness Test*, including 20-m pacer, curl-ups, flexed arm hang, skinfolds of triceps, skinfolds of calf, sit and reach with left leg, and sit and reach with right leg. A simple multivariable analysis (MANOVA) was used to analyze the differences on physical fitness test-items between participants with and without cognitive impairments. Results showed a significant difference (Wilks' Lambda = .21, $F[7, 67] = 37.19$, $p = .00$) between two groups. The follow-up tests also showed significant difference on all test-items but skinfolds of triceps and calf between two groups. These findings revealed that young adults with cognitive impairments showed lower fitness performance on cardiovascular endurance, muscular strength and endurance, and range of motion than their normal peers.

Key words: physical fitness, young adults, and cognitive impairments.

Physical fitness is defined as a state characterized as an ability to perform and sustain the daily activities and demonstration of the traits or capacities that are associated with a low risk of premature development of diseases and conditions that are related to the movement (Winnick & Short, 2005). It refers to those components of health-related physical fitness that are affected by habitual physical activity, including cardiovascular endurance, muscular strength and endurance, body composition, and flexibility (Dunn & Leitschuh, 2006). Research focusing on the overall health-related physical fitness and its specific components, because of their unique importance for performing and maintaining active and healthy lifestyle, has been extensively conducted not only on normal populations (Sherrill, 2004), but also on special populations (Winnick & Short, 2005), including individuals with cognitive impairments (Onyewadume, 2006).

It is well-documented in the literature that children, adolescents, and matured adults with cognitive impairments demonstrate inferior physical fitness performance when compared to their counterparts without disabilities (Eichstaedt & Lavay, 1992). The pioneer research completed by Parick, Widdop, and Broadhead (1970) demonstrated that physical fitness scores for children and adolescents with mild cognitive impairments to be 2 to 4 years behind that of their peers who did not have disabilities, which have been supported in follow-up studies (e.g., Wang & Eischstaedt, 1980; Neinhuis, 1989; Onyewadume, 2006). Research with those matured adults with cognitive impairments have revealed even greater inferior physical fitness levels (e.g., Lavay, Zody, Solko, & Era, 1990; McCubbin & Jansma, 1987).

The reported cardiovascular fitness of individuals with cognitive impairments, because of their short statures and limited participations (Shephard, 1990; Onyewadume, 2006), were found lower than their normal peers (Cooper et al., 1999). Gillespie (2003), for example, compared the cardiovascular fitness scores of children (*M* of age = 96 months) with cognitive impairments (*n* = 30) and their peer without disabilities (n = 30) based on the data collected from performing 20-m shuttle run. The results of this study showed that children with mild cognitive impairments had a significantly lower level of aerobic fitness than their peers without disabilities based on the t-test on the raw data between these two groups at a statistical level of significance at .05. This finding was supported in other studies (e.g., Pitetti & Fernhall, 2004; Onyewadume, 2006),

The reported muscular strength and endurance performance by individuals with cognitive impairments was also poorer than normal peers (Shephard, 1990). Pitetti and Yarmer (2002), for example, compared the muscular strength and endurance of children and adolescents (age from 8 to 18) with mild cognitive impairments (*n* = 269) and their normal peers (*n* = 449) based on the data collected from performing such instruments as the pull dynamometer for the back and leg strength. The results of this study showed that individuals with cognitive impairments exhibited a significantly lower level of low body muscle strength than those without disabilities based on the ANOVA at a statistical level of significance at .05. This finding was consistent with the findings found in other studies (e.g., Fernhall, Pitetti, Stubbs, & Stadler; 1996; Onyewadume, 2006).

The reported body of composition by persons with cognitive impairments was different from their normal peers (Kelly, Rimmer, & Ness, 1986). Petetti , Yarmer, and Fernhall (2001) investigated the body composition of children and adolescents with mild cognitive impairments (*n* = 268) and without disabilities (*n* = 606) based on body mass index for evaluating the body of composition. The results showed that females with cognitive impairments were overweight and males with same disability tended to be overweight in terms of the cutoff points (Cole, Bellizzi, Flegal, and Dietz; 2000). Similarly, Reid, Montgomery and Seidle (1985) examined 185 matured adults with this disability and found the females were clearly obese and males had extra body fat, which was similar to the results from the other studies (e.g., Fox & Rotatori, 1982; Skrobak-Kaczynski & Vavik, 1980).

Research on another fitness component, flexibility, of people with cognitive impairments has not been conducted extensively as the above fitness components. This was probably because these individuals might have muscular hypotonia and lax ligaments (Sherrill, 2004), resulting in a possible view that the flexibility of these persons might not be a major concern. Recent studies on this issue, however, indicated that individuals with cognitive impairments demonstrated poor flexibility performance. In the investigation

conducted by Onyewadume (2006), the trunk flexion and extension of adolescents with cognitive impairments were tested with a Lafayette flexometer. The results of this study showed that these adolescents (*n* = 30) exhibited poorer range of motion than their peers without disabilities (*n* = 30) at a statistical level of significance at .05.

Despite the copious literature in favor of a superior physical fitness in normal individuals over people with cognitive impairments, several studies reported that no significant difference in physical fitness was found between individuals with and without cognitive impairments. Parick, Dobbins, and Broadhead (1976) revealed that performance on specific items of physical fitness for individuals with cognitive mild impairments were similar to those peers without disabilities. The findings from this study was supported in an investigation conducted by Pitetti, Millar, and Fernhall (2000), in which most physiological responses to a discontinuous treadmill protocol by both individuals with and without disabilities were similar. This indicates that a significant need exits for investigating fitness performance of individuals with cognitive impairments further.

Another significant need also exits in the literature. Previous studies placed their focuses on fitness performance of individuals with cognitive impairments who were children (ages under 13; e.g., Gillespie, 2003), adolescents (ages from 13 to18; e.g., Pitetti et al., 2001), and matured adults (ages above 25; e.g., Reid et al., 1985). This indicates that a significant need did exits for investigating physical fitness performance of young adults (ages from about 19 to about 25) with cognitive impairments. Therefore, the purpose of this study was to compare the physical fitness between young adults with and without disabilities. Specifically, the overall fitness performance across all the fitness components and the specific fitness performance on each of the four fitness components were compared between these two groups in this comparative study.

Method

Participants

Participants recruited in this study were 75 young adults, including 34 young adults with mild cognitive impairments (14 females, 20 males; *M* of age = 21.79) and 41 without disabilities (23 females, 18 males; *M* of age = 21.88). Participants with cognitive impairments were sampled from a young adult program in a special post-secondary school conveniently. The staff from this school identified these individuals were categorized with mild cognitive impairments. However, specific assessment tools administered to determine the level of cognitive impairments were not reported by the staff from this school. Participants without disabilities were voluntarily recruited from an undergraduate program at a university. All the participants were measured in seven test-items for evaluating the performance of four physical fitness components.

Test-Items

The seven test-items employed were selected based on *The Test-Item Selection Guide for Youngsters with Mental Retardation* from *The Brockport Physical Fitness Test Manual* (Winnick & Short, 1999). These test-items are 20-m pacer, skinfolds of triceps , skinfolds of calf, modified curl-ups, flexed arm hang, back-saver

sit and reach with keeping left leg straight, and back-saver sit and reach with right leg straight. The 20-m pacer was used for testing the aerobic functioning, the skinfolds of triceps and the skinfolds of calf were employed for testing the body composition, and the modified curl-ups and the flexed arm hang were used for assessing muscular strength and endurance, and the back-saver sit and reach with left leg straight and the back-saver sit and reach with right leg straight were selected for testing the flexibility as stated in *The Brockport Physical Fitness Test Manual* (Winnick & Short, 1999).

The 20-m pacer was used for measuring aerobic functioning (Short & Winnick, 2005a). With this test-item, a participant ran as long as possible back and forth across a 20-m (29.9 yd) distance at specified pace. This pace got faster each minute that was controlled by a beep from a tape sounds. At the sound of the beep, a participant turned around and ran back to the other end. If he or she reached an end before the beep, he or she had to wait for the beep before running the other end. This continued until a participant could no longer reach an end before the beep. A test trail was given to a participant and the number of completed laps was recorded as the score. This test item was documented to be valid and reliable for assessing aerobic capacity for persons with cognitive impairments (e.g., Cureton, 1994; Short & Winnick, 1999).

The skinfolds of triceps and calf were used for measuring the body composition (Short & Winnick, 2005b). A skinfold caliper by *The Brockport Physical Fitness Test* (Winnick & Short, 1999) was used to test the thickness of skinfolds at the triceps and calf. The triceps skinfold was taken over the triceps muscle at a location midway between the tip of the shoulder and the elbow. The calf skinfold was taken on the inside of the leg at about the level of maximal calf girth when the foot was placed flat with the knee flexed at an angle of 90 degree. A total of three trials were given on each site and the median score among the three trials was selected as the raw score. The skinfolds on the sites were believed to have a good validity and reliability for assessing the body composition for persons with cognitive impairments (e.g., Lohman, 1994; Safrit & Wood, 1995).

The flexed arm hang and modified curl-up were used for assessing muscular strength and endurance (Short & Winnick, 2005c). In the flexed arm hang, a participant tried to keep a flexed arm position by grasping the bar with an overhand grip, while hanging from a bar for a time. A trial was given and the number of seconds was recorded as the score. In the modified curl-up, the supine position with both knees bent at an angle about 140 degree and feet placed on floor were taken by a participant who completed as many curl-ups as possible. As he or she curled up, the hands slided along the thighs until the fingertips contacted the patellae. A trial was given and the number of curls-up was recorded as the raw score. These test items have been validly and reliably used to assess persons with cognitive impairments (e.g., Jette, Sidney, & Cicutti, 1984).

The back-saver sit and reach with keeping the right leg straight and the back-saver sit and reach with keeping the left leg straight were used for measuring the flexibility (Short & Winnick, 2005d). A testing apparatus named as a commercially built flex-tester by *The Brockport Physical Fitness Test* (Winnick & Short, 1999) was used to test the flexibility. A participant began the test by removing his or her shoes and sitting down at the apparatus. One leg was

fully extended with the foot of this leg against the end of apparatus and the knee of another leg bent with the foot of flat on the floor 2 to 3 in. to the side of the straight knee. Arms were extended forward with the hands' palms down over the measuring scale of the apparatus. A trial for each leg was given and the number of inches reached was recorded as the score. These test items were valid and reliable in assessing persons with disabilities (e.g., Plowman & Corbin, 1994; Short & Winnick, 1999).

Since motivation and understanding have been reported as major concerns for measuring the fitness performance of individuals with cognitive impairment (Onyewadume, 2006; Fernhall et al., 1996), several appropriate steps were taken before a participant got in formal assessments. Each of the participants was familiarized with each of the seven test items through listening the explanation, observing the demonstration, and conducting several practical trials how to perform a test item until he or she understood the approach to complete the test item and displayed proper forms to perform the test item. When a participant performed a test item, a tester was acted as a partner of this participant (e.g., as a pacer in performing the 20-m pace).

Data Analysis

A simple multivariable analysis (MANOVA) was employed to check the differences on all the fitness test items between males and females to see if male and female participants could be included in the same group in the data analyses. If no significant differences could be found between male and female participants, the simple MANOVA was then used to check the overall difference on all the test-items between participants with and without cognitive impairments. If there was a significant difference between participants with and without cognitive impairments, the follow-up tests were used to analyze the difference on each of the seven test items between participants with and without cognitive impairments.

Table 1. *The Means and Standard Deviations (Means ± Standard Deviations) Based on All the Test-Items between Female Participants (FP) and Male Participants (MP) and between Participants with Cognitive Impairments (PCI) and Participants without Disability (PWD)*

Test Items (unit)	FP (n=37)	MP (n=38)	PCI (n=34)	PWD (n=41)
20-m pace (laps)	28.86±20.01	22.82±16.73	11.85±7.80	37.37±16.84
Skinfolds of triceps (mm)	18.68±5.54	17.82±8.96	17.97±7.41	18.46±7.53
Skinfolds of calf (mm)	17.76±7.48	19.13±8.82	19.91±9.42	17.24±6.84
Flexed arm hang (s)	12.54±12.45	12.10±11.65	5.69±7.21	17.82±12.41
Modified curl-up (times)	33.38±19.76	31.82±22.61	13.24±8.80	48.63±12.82
Back-saver— right (cm)	24.59±12.78	20.71±9.35	19.41±8.73	25.30±12.49
Back-saver— left (cm)	24.73±12.96	21.19±9.20	19.38±7.61	25.89±12.96

Results

The descriptive statistics, the means and standard deviations based on all the fitness test-items by the gender and the disability, are shown in Table 1. The result of MANOVA indicated that overall difference over all the test- items between male participants and female participants was not statistically significant, Wilks' Lambda = .91, F (7, 67) = .99, p = .45, and partial $\eta2$ = .09. The results presented in Table 2 clearly indicated that univariate tests on each of the seven test-items between male participants and female participants were not statistically significant. The result of MANOVA, however, demonstrated that overall difference over all the fitness test-items between participants with and without cognitive disabilities was statistically significant, Wilks' Lambda = .21, F (7, 67) = 37.19, p = .00, and Partial $\eta2$ = .80. The results of follow-up tests on each of the seven test-items between these two groups were statistically significant as well as shown in Table 3.

Table 2. *The Results of Univariate Tests on Each of the Severn Test-Items between Female Particpants and Male Participants*

Test-Item	F	df	p	Partial Eta Squared
20-m pace	2.20	1,73	.16	.03
Skinfolds of triceps	0.25	1,73	.62	.00
Skinfolds of calf	0.53	1,73	.47	.01
Flexed arm hang	0.03	1,73	.87	.00
Modified curl-up	0.10	1,73	.75	.00
Back-saver— right	2.27	1,73	.14	.03
Back-saver— left	1.86	1,73	.18	.03

Table 3. *The Results of Follow-up Tests on Each of the Severn Test-Items between Participants with Cognitive Impairments and Participants without Disabilities*

Test-Item	F	df	p	Partial Eta Squared
20-m pace	66.11	1,73	.00	.48
Skinfolds of triceps	0.08	1,73	.77	.00
Skinfolds of calf	2.01	1,73	.16	.02
Flexed arm hang	25.37	1,73	.00	.26
Modified curl-up	174.64	1,73	.00	.71
Back-saver— right	5.37	1,73	.02	.07
Back-saver— left	6.66	1,73	.01	.08

Discussion

Since no significant difference was found on all the test- items between male participants and female participants based on the result of MANOVA (Wilks' Lambda = .91, F [7, 67] = .99, p = .45, and partial $\eta2$ = .09), each of the two groups, participants with cognitive impairments or participants without disabilities, included male participants and female participants for analyzing fitness difference between these two groups. The finding focusing on all the test-items indicated that participants without disabilities had significantly higher fitness performance than those with cognitive

impairments (Wilks' Lambda = .21, F [7, 67] = 37.19, p = .00, and Partial $\eta2$ = .80). It was primarily resulted from significant differences on those test-items in the aerobic functioning, the flexibility, and the muscular strength and endurance, as presented in Table 3, but not from the body composition.

Four aspects are valuable for discussion based on the above findings. First, the significant difference on the 20-m pace found in this investigation confirms that young adults with cognitive impairments have significantly poorer aerobic functioning than those without disabilities. In this study, young adults with cognitive impairments performed their 20-m paces in a mean of 11.85 laps, while those without disabilities in a mean of 37.73 laps. These resulted in that a statistically significant difference on the aerobic functioning between the two groups in the use of MANOVA (F [1, 73] = 66.11, p = .00, and Partial $\eta2$ = .48). This finding is consistent with the results found in most studies where children, adolescents, and matured adults with cognitive impairments have poorer aerobic functioning (e.g., Gillespie, 2003; Pitetti et al., 2001; Reid et al., 1985).

Aerobic functioning or cardiovascular endurance has been considered an integral part of physical fitness for many years (Short & Winnick, 2005a). The poor performance by individuals with cognitive impairments might result from their physical characteristics, medical conditions, and practical opportunities. It has been documented that individuals with cognitive impairments most likely had short statures and extra weights (Dunn & Leitschuh 2006); that they might have such medical conditions as congenital heart disorders (Eichstaedt & Lavay, 1992); and that they had little opportunities to participate in proper health-related physical fitness activities (Sherrill, 2004). The aerobic functioning by individuals with cognitive impairments was therefore poorer than their normal peers, which has been found in this study and the majority of previous studies.

Second, the significant differences on the flexed arm hang and modified curl-up found in this investigation reveals that young adults with cognitive impairments have significantly poorer muscular strength and endurance than those without disabilities. In this study, young adults with cognitive impairments performed their flexed arm hang in a mean of 5.69 s, while those without disabilities in a mean of 17.82 s; and the modified curl-up in a mean of 13.24 times, while those without disabilities in a mean of 48.63 times. It resulted in significant differences between these two groups on the flexed arm hang (F [1, 73] = 25.37, p = .00, and Partial $\eta2$ = .26) and modified curl-up (F [1, 73] = 174.64, p = .00, and Partial $\eta2$ = .71). This finding supports the results found in previous studies where individuals with cognitive impairments have poorer muscular strength (e.g., Pitetti & Yarmer, 2002; Pitetti & Fernhall, 2004; Onyewadume, 2006).

Muscular strength and endurance is conceptualized as the subcomponent of health-related physical fitness. It includes the ability to exert force through muscular contraction and the ability to sustain the production of force over a period of time (Short & Winnick, 2005c). The poor level of muscular strength and endurance by individuals with cognitive impairments are believed to be associated with several variables besides the limited routine of physical activities (Onyewadume, 2006). This may be resulted from their risk for developing osteopenia or osteoporosis (e.g., bone fratures;

Pitetti & Yarmer, 2002) since muscle strength is directly related to bone mineral density (Baily, Faulkner, & McKay, 1996). This may be associated with poor cardiovascular functioning by these individuals as well as confirmed in several investigations (e.g., Fernall et al., 1996).

Third, the significant differences on the back-saver sit and reach with keeping the right or left leg straight found in this study indicates that young adults with cognitive impairments have significantly poorer flexibility than the peers without disabilities. In this study, young adults with cognitive impairments performed their sit and reach with keeping the right leg straight in a mean of 19.41 cm, while those without disabilities in a mean of 25.30 cm; and their sit and reach with keeping the left leg straight in a mean of 19.38 cm, while those without disabilities in a mean of 25.89 cm. These resulted in significant differences between the two groups (F [1, 73] = 5.37, p = .02, and Partial $\eta2$ = .26 for right leg straight and F [1, 73] = 6.66, p = .01, and Partial $\eta2$ = .71 for left leg straight). This finding shows that a need for flexibility exercises exits for individuals with cognitive impairments (Dun & Leitschuh, 2006).

Flexibility, or range of motion, is usually defined as the extent of movement possible in a single joint (Short & Winnick, 2005d). This subcomponent of health-related physical fitness has not been studied and emphasized extensively as other subcomponents in literature. Reasons why this happened might result from an inferable opinion that the flexibility of persons with cognitive impairments would be fine because these individuals had poor muscle tones, joint looseness, and abnormal range of motion, which could be an advantage in activities as gymnastics that requiring flexibility (Sherrill, 2004). The finding found in our investigation, however, does not support this inferable opinion since we found that young adults with cognitive impairments have significantly poorer flexibility than their normal peers. More investigations are clearly needed on this aspect in the future studies.

Fourth, no significant differences on the skinfolds of triceps and calf were found between the two groups in this study, implying that young adults with cognitive impairments have similar body composition to those without disabilities. In this investigation, young adults with cognitive impairments obtained their skinfolds of triceps in a mean of 17.97 mm, while the normal peers in a mean of 18.46 mm; and their skinfolds of calf in a mean of 19.91 mm, while their normal peers in a mean of 17.24 mm. These resulted in no significant differences between these two groups (F [1, 73] = 0.08, p = .77, and Partial $\eta2$ = .00 for triceps and F [1, 73] = 2.01, p = .16, and Partial $\eta2$ = .02 for calf). This finding is contrary to the results found in most previous studies where people with cognitive impairments show poorer body composition (e.g., Fox & Rotatori, 1982; Petetti et al., 2001; Cole et al., 2000).

The above finding does not imply that participants in these two groups, young adults with and without cognitive impairments, have normal body compositions. This might be resulted from that young adults in both groups had abnormal body composition, implying that this study could not find any significant differences on the skinfolds of triceps and calf between these two groups because both young adults with and without cognitive impairments were overweight or obese. It has been reported that the thickness of the skinfolds of triceps in young adults approximating the ideal body mass was 7.8 mm for males and 15.6 mm for females (Shephard,

1990). However, the thickness values we obtained on the same site for males and female participants in each group, as presented in Table 4, were higher than the values specified by Shephard (1990). These imply that participants either with or without cognitive impairments might have extra weights. This finding is called for further comparative studies on this aspect in the future studies.

Table 4. *The Thickness Values of the Skinfolds of Triceps Based on Gender and Disability*

	Males	Females
Cognitive Impairments	17.80	18.21
Without disabilities	17.83	18.95

In summary, the results obtained this comparative study revealed that participants without disabilities demonstrated a significantly higher level of the physical fitness than participants with cognitive impairments. This was resulted from significant differences on the aerobic functioning, the flexibility, and the muscular strength, but not from the body composition because the further analysis on each of the four fitness components indicated that significant differences were found over such test-items as the 20-m pacer, the back-saver sit and reach, and the flexed arm hang and modified sit ups; but no significant differences were found on the skinfolds of triceps and calf. It seems that more comparative studies are needed to study the flexibility and body composition of young adults with cognitive impairments.

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